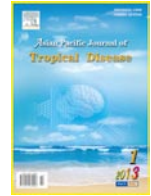




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# First determination of impact and outcome indicators following indoor residual spraying (IRS) with deltamethrin in a new focus of anthroponotic cutaneous leishmaniasis (ACL) in Iran

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## PEER REVIEW

## ABSTRACT

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**Comments**

The paper is more appropriate. In addition to evaluate the impact and outcome indicators, the susceptibility status of main Cutaneous leishmaniasis vectors to the WHO-recommended used pesticide is also evaluated for further decision on disease control using pesticides.

(Details on Page 8)

**Objective:** To determine the impact and outcome indicators following residual spraying with deltamethrin in new focus of cutaneous leishmaniasis during 2010–2011. **Methods:** Deltamethrin WP 5% was applied at 25 mg a.i./m<sup>2</sup>. in intervention area using Hudson compression sprayer. Sticky trap were used to collect sand flies twice each month from human and animal dwelling in either or intervention and control areas. **Results:** The incidence of disease was significantly decreased (3.65 versus 8.43). There was a significant difference between treats and control areas on blood fed and gravidity of sand flies. **Conclusions:** The results of current study clearly indicated that indoor residual spraying caused a significant decline of density, blood fed and gravidity of vectors resulting a sharp reduction of disease incidence.

## KEYWORDS

Cutaneous leishmaniasis, Residual spraying, Deltamethrin, Iran

## 1. Introduction

Leishmaniasis is a complex disease caused by several species of the genus *Leishmania*. It is spread to human being by biting of female sand flies[1]. Cutaneous leishmaniasis (CL) is an important health problem in Iran.

It is reported from 50% of the 31 provinces. Both Zoonotic cutaneous Leishmaniasis (ZCL) and Anthroponotic cutaneous Leishmaniasis (ACL) forms of disease are endemic in Iran[2–6]. Disease also have been emerged in new foci during recent decades[7]. Two epidemiological forms of CL occur in Bam district, ACL is mainly limited

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to the city, its causative agent is *Leishmania tropica* with its main reservoir of host of human[8]. However ZCL is the more prevalent form. Anthroponotic cutaneous leishmaniasis is a serious problem due to its difficulty of treatment and longer duration, hence potentially severe long-term complications[9].

After the massive earthquake of Bam in December 2003 the prevalence of CL cases increased among school children. It increased from 2% in 2005 to 5% in 2008 (Unpublished data). After the earthquake, a new emerging focus of ACL due to *L. tropica* in rural areas of Dehbakri County, were confirmed. According to published data, this paper is the first report of a gradually establishing new ACL focus in rural communities after earthquake. Natural disaster completely provides favorite condition for vector breeding places as well as propagation of agent in the displaced population[10].

The activity of sand flies in Bam start from late May and extends to mid October. It has two peaks in June and September respectively[11]. Control of sand flies using pesticides appears to be more effective for reducing disease transmission. Residual spraying human and animal dwellings depends on the availability of an appropriate public health infrastructure, adequate supplies of insecticide, spraying equipment and trained personnel[12]. The synthetic pyrethroid, deltamethrin have been used against sand flies in some countries such as Bolivia and Brazil and were found effective[13-15]. This insecticide also is recommended for malaria control in the country. The aim of this study was to determine the impact and outcome indicators following residual spraying at 25 mg a.i/m<sup>2</sup> inside human and animal dwellings.

## 2. Material and methods

### 2.1. Study area

After preliminary survey, two counties of Dehbakri and Mohammad Abad were selected as intervention and control, respectively. They had highest incidence of CL in 2009 (5.9 and 3.9. Dehbakri County is located at the foothill Mountain with the mean altitude of 2000 m above sea level. It is 48 km far from southwestern of Bam district (Figure 1). The climate is moderate, with mild summers (25–35 °C) and winters (5 to 10 °C). The condition is favorite , for attraction of residents of Bam. Maximum and minimum temperatures are 40 °C and –5 °C in July and December , respectively. The total annual rainfall is 220 mm. The minimum and maximum of relative humidity is between 45%–92% in July and January.

### 2.2. IRS program

Indoor residual spraying was carried out two weeks prior to seasonal activities of sand flies from April to 2010. Deltamethrin WP 5% was applied at 25 mg a.i/m<sup>2</sup>.in intervention area using Hudson compression sprayer. Supervised spray operations were completed within 10 d. Spray coverage was 95% covering 300 houses.

### 2.3. Vectors density

Sticky trap were used to collect sand flies twice each month from human and animal dwelling in either or intervention and control areas. All the entomological



**Figure 1.** Dehbakri and Mohammad Abad counties, located in Bam district, Kerman province, southeast of Iran.

activities were started two weeks after residual spraying. Traps were set at dusk and then sand flies were collected at dawn. A total of 120 sticky traps were set at any time in both sites. Trapped sand flies removed from sticky papers with needles. They were washed with absolute ethanol, and then transferred into micro tubes filled with 96% ethanol. Tubes were kept frozen at  $-20^{\circ}\text{C}$  for species identification.

#### 2.4. Insecticide susceptibility test

The susceptibility tests were carried out according to the guideline of WHO (1981). Sand flies were transferred to the exposure tubes lined with deltamethrin 0.05%, and DDT 4%. Mortality was recorded at interval times and the result was counted after 24 h recovery period. During the holding period, the insects were supplied with cotton pad of water in 10% sugar solution. All the tested sand flies were mounted separately using Pori's media for species identification. Male and female were considered separately. The  $LT_{50}$  and  $LT_{90}$  values were calculated by plotting the regression lines.

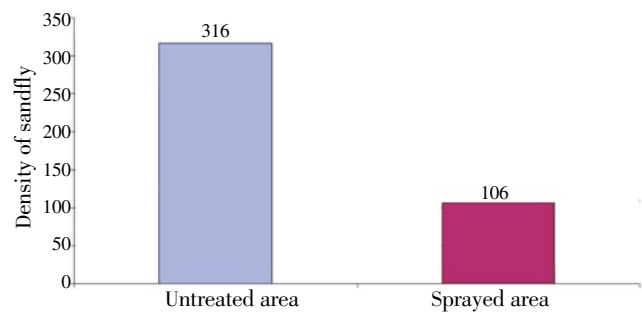
#### 2.5. Statistical analysis

The data were statistically analyzed using SPSS software. The chi-square test was used to determine any significant difference between demographic factors and disease prevalence.

### 3. Results

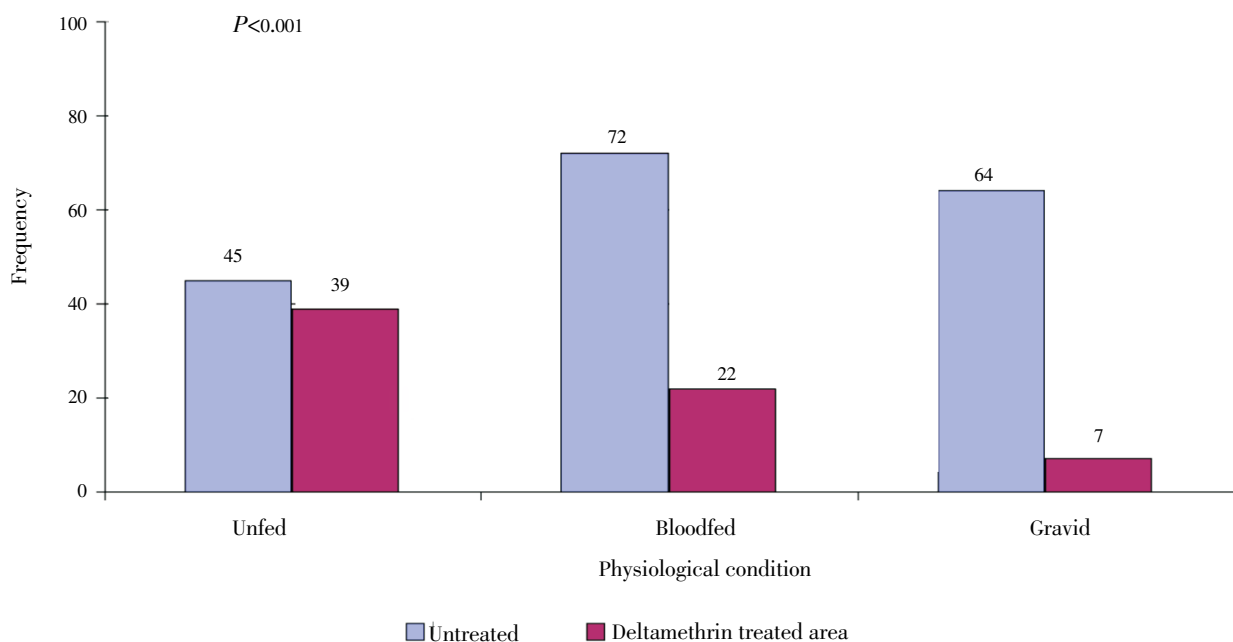
The main impact factors including density, abdominal condition and susceptibility status of main vector to deltamethrin were measured and then compared in both sites. Outcome indicator including incidence of disease also were compared.

Statistical analysis showed significant difference in the density of sand flies in two sites. A total of 422 phlebotominae sand fly were collected from indoor places of two sites, from which a total of 106 (25%) were collected for treatment area and the remaining from county control area. Results clearly exhibited that the IRS was effective in reducing the density of sand flies in the treated site (Figure 2).



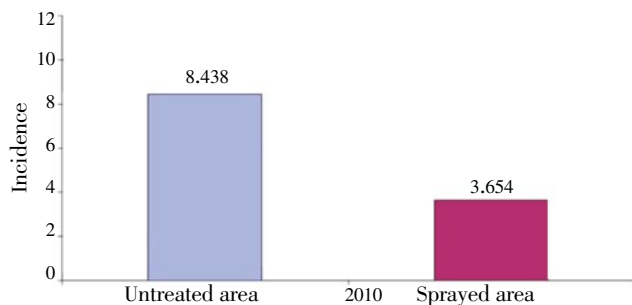
**Figure 2.** Effect of IRS on density of sand flies after intervention at treated and control areas at Bam district, southern Iran.

Study on physiological condition of sand flies also resulted in decreasing of blood fed (22 versus 72). The gravid sand flies (7 versus 64) is also significant (Figure 3).



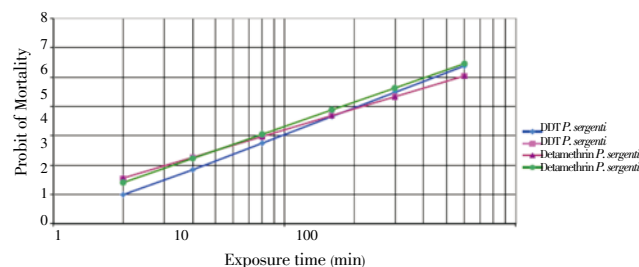
**Figure 3.** Effect of IRS on physiological condition of sand flies caught after intervention at treated and control areas at Bam district, Southern Iran.

The main outcome of IRS is the reduction of disease incidence. The results exhibited that indoor residual spraying played an important role in decreasing of incidence of disease (3.654 versus 8.438) (Figure 4).



**Figure 4.** Effect of IRS on incidence of ACL disease after intervention at treated and control sites.

The incidence of disease were 3.9 in control area. The figure was 5.9 in treated site in 2009. The figure clearly indicate a sharp decline of incidence due to intervention even relation to the past year.



**Figure 5.** Probit regression lines DDT 4% and Deltamethrin 0.05% against *P. papatasi* and *P. sergenti*.

#### 4. Discussion

Vector control is an essential method for elimination of vector borne diseases strategy in the world. Among the various options for vector control, IRS with appropriate insecticides is a key intervention. It can be used to reduce vector population and interrupt disease transmission[16].

Equipment and procedures after spraying is essential in order to achieve the necessary level of reduction of vector densities to interrupt disease transmission[17-18]. This study is the first attempt for evaluation of IRS with deltamethrin in a randomized controlled trial against ACL. The efficacy of the vector control was evaluated by comparing the proportions of sand flies collected from treated and control sites. The results indicated that deltamethrin spraying affected all the impact and outcome indicators. These elements decreased considerably in treated sites compared to Mohammad Abad as control area.

In a similar study in Bihar, India the results showed deltamethrin was effective for sand flies control[19]. Recent research in some countries exhibited that IRS could be very powerful tool in substantially reducing the vector population[20]. The residual spraying was carried out during 1950-1968. In Iran the houses had been treated with

DDT for malaria control. For the last 3 decades, DDT was the choice insecticide for malaria and leishmania control in Iran. Recent field trials in hyper endemic zoonotic cutaneous leishmaniasis areas of Iran demonstrated that DDT is not able to reduce *Leishmania* incidence compared to deltamethrin[21]. Pyrethroids are now being regularly used for malaria and leishmaniasis control in Iran. Our results showed that deltamethrin WP could be consider as an appropriate insecticides for ACL control. Sprayed surfaces with deltamethrin can be effective for several months after spraying. It appears highly effective for the control of leishmaniasis by reduction of sand flies density, considerable decreasing of blood fed and gravidity. According to recent study of Aghaei Afshar[22], it is approved that one residual spraying per year is adequate for control of disease in the same areas in Iran. Continuous monitoring and mapping of insecticide resistance in the vector population is essential[22].

#### Conflict of interest statement

We declare that we have no conflict of interest.

#### Acknowledgements

This study was financially supported from the Leishmaniasis Research Center, Kerman University of Medical Sciences and the School of Public Health, Tehran University of Medical Sciences, project No.10487. We wish to express our sincere thanks to the Iranian Centre of Diseases Management, Ministry of Health and Medical Education for providing facilities for this study.

#### Comments

##### Background

Leishmaniasis is the important health problem in the world as well as in Iran. The paper is the first work which is conducted in the region. The paper is discussing the main important impact and outcome indicators of using Indoor residual spraying on sand flies in the new focus of cutaneous leishmaniasis for control of disease.

##### Research frontiers

Information gathered from the paper indicated that the intervention with Deltamethrin completely reduced the incidence of disease as well as vector population in the treated areas compared to control areas.

##### Related reports

This is the first time, reporting the intervention for reducing the disease incidence. Although there are a number of paper in the area of Malaria vector control

(ladonni *et al.* 2002) but regarding to sand–fly control (vector and disease) with emphasis to the main important impact and outcome indicators, there is only limited published papers (Vatandoost *et al* 2012). I would like to inform the methods as well as the results of study is reliable.

### Innovations & breakthroughs

This is the first report of evaluation of IRS for the control of cutaneous leishmaniasis with emphasizing on impact and outcome indicators. in the country and probably in the region.

### Applications

This is the first report of evaluation of IRS for the control of cutaneous leishmaniasis with emphasizing on impact and outcome indicators. in the country and probably in the region.

### Peer review

The paper is more appropriate. In addition to evaluate the impact and outcome indicators, the susceptibility status of main cutaneous leishmaniasis vectors to the WHO–recommended used pesticide is also evaluated for further decision on disease control using pesticides.

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